



## PCI Express® Solutions

Field-Proven, Interoperable and Standards-Compliant Portfolio

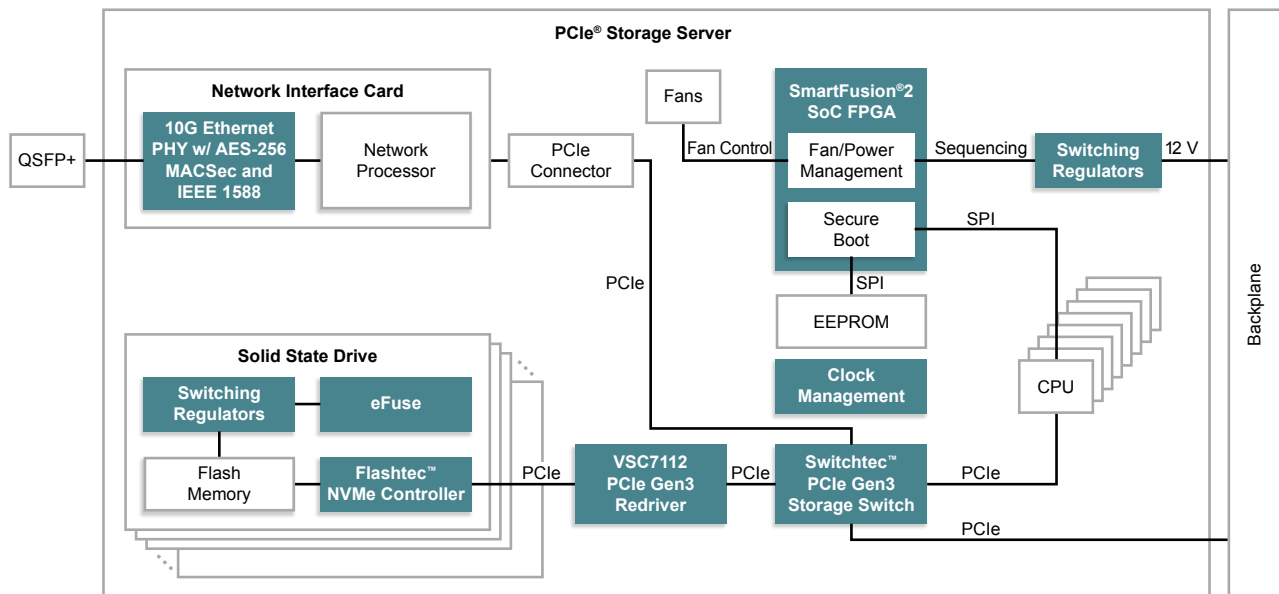


PCI Express® (PCIe) is a widely deployed bus interconnect interface that is commonly used in server platforms. Increasingly, it is also used as a storage and GPU interconnect solution. PCIe Gen3 supports 8 GT/s of throughput per PCIe lane and Gen4 supports 16 GT/s. Typical implementations utilize x2, x4, x8 and x16 lane width interconnect configurations—directly from the host root complex or through PCIe switches to endpoint PCIe devices.

Microchip is a leader in PCIe, having introduced multiple industry firsts. Highlights include:

- PCIe Gen3 SAS/SATA RAID controller
- The industry's highest-density and lowest-power Gen3 PCIe switches, Switchtec™ PSX and PFX
- PCIe Gen3 NVMe Flash controller (Flashtec™), followed by a second-generation introduction of the industry's fastest PCIe Gen3 NVMe SSD controllers
- PCIe Gen3 redriver with EQNOX™ adaptive equalization
- Flash-based FPGAs and SoCs used in CPLD functions with integrated PCIe endpoint implementations

Microchip offers a flexible product portfolio to intelligently design your PCIe system for data center, communications, defense and industrial applications. Our industry-leading PCIe solutions include storage and fanout switches, NVMe controllers, NVRAM drives, redrivers and timing solutions and Flash-based FPGAs and SoCs.



## Advantages

### Switchtec PCIe Switches

- Options from 24 to 96 lanes
- Industry's most flexible port bifurcation, from  $\times 2$  to  $\times 16$  lanes per port
- Highest port and Non-Transparent Bridge (NTB) density, with up to 48 ports and 48 NTBs
- Highest switch partition density
- Industry's first integrated programmable processor
- Industry's first integrated enclosure management solution
- PFX-I supports industrial temperature ranges,  $-40^{\circ}\text{C}$  (TA) to  $105^{\circ}\text{C}$  (TJ)

### Flashtec NVMe Controllers

- World's first and fastest enterprise PCIe NVMe controller, with up to 850K IOPS and up to 8 TB
- Software-defined flash: flexible, programmable architecture optimized for cost, performance and endurance
- Enterprise-class reliability, availability and serviceability with NVMe management features and industry's only dual-port controller

### Flashtec NVRAM Drives

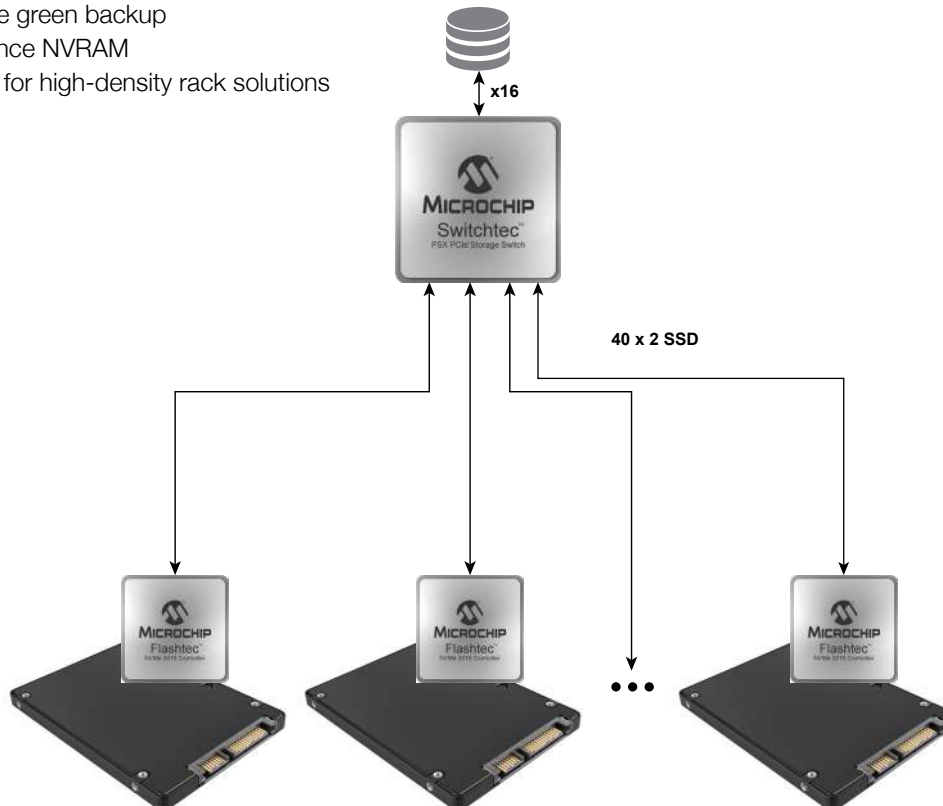
- Non-volatile DRAM with over 10 million IOPS, sub-microsecond latency
- Industry-standard interfaces that are application-friendly for ease of integration
- Zero-maintenance green backup
- Unlimited endurance NVRAM
- Small form factor for high-density rack solutions

### Signal Integrity

- PCIe Gen 3.0 solutions supporting  $\times 1$  to  $\times 8$  lanes
- Adaptive EQ and de-emphasis with up to 30 dB loss compensation
- BOM integration and smaller package sizes save board cost and area
- Low-power modes scale with speed and drive strength
- High ease of use

### Timing Solutions

- End-to-end offerings, including synthesis, rate conversion, attenuation and distribution
- Ultra-low-jitter (160 fs) synthesizers and attenuators
- Ultra-low additive jitter, cost-efficient buffers
- Application specific with custom configuration—MiClockDesigner™
- Validated with the Agilent Time Domain PCI-SIG Compliance Software Suite



## PCIe Signal Integrity

Improve weak or degraded signals with Switchtec PCIe signal integrity solutions. With industry-exclusive EQNOX™ adaptive equalization add Switchtec's PCIe redrivers and crosspoint switches deliver excellent performance in a compact footprint with flexible lane configurations for Gen1/2/3 applications, including passthrough buffer, non-blocking matrix switching, replication of inputs to multiple outputs and multiplexing.



Product	Ports	Max Rate	Part Type	Receiver Type	Max Link Width
VSC3340-01	40 × 40	6.5G	Crosspoint Switch	CTLE	PCIe® 2.0 × 16
VSC3316	16 × 16	11.5G	Crosspoint Switch	CTLE	PCIe 3.0 × 8
VSC3308	8 × 8	11.5G	Crosspoint Switch	CTLE	PCIe 3.0 × 4
VSC7112	4, Dual 2 × 2	8.5G	Redriver with mux/demux	Adaptive CTLE	PCIe 3.0 × 2

## Clock Synthesis

The miClockSynth™ family of high-performance, any-rate multiplier and frequency synthesizer devices simplifies board design by generating ultra-low-jitter clock signals from a single crystal or crystal oscillator while generating additional independent frequency families.



Product	Frequency Families	Outputs	Inputs	Jitter Performance RMS	Package (mm)
ZL3025x	1	Up to 3 diff/6SE, 1 Hz–1035 MHz	10 M–1250 MHz	160 fs	5 × 5 QFN
ZL3026x	4	Up to 10 diff/20SE, 1 Hz–1035 MHz	10 M–1250 MHz	170 fs	8 × 8 QFN

## Gen 1-4 PCIe Clock Generators

Product	Independent Output Freq. Families	Inputs	Crystal Input Freq. Range	Xtal Oscillator or CMOS Input Freq. Range	Low-Jitter APLLs	Typical Jitter fs RMS	Default Output Configurations	Output Freq. Range	Host Bus	Supply Voltage	Pkg Size (mm)
ZL30281	1	1 XTAL	25M	25 M	1	160	4	25 M, 100 M	SPI/I <sup>2</sup> C	3.3 + 1.8	5 × 5
ZL30282	2	2 XTAL	50M	50 M	1	160	8	25 M, 75 M, 100 M	SPI/I <sup>2</sup> C	See note	8 × 8

2.5V only, 3.3V only, 1.8V + 2.5V, 1.8V + 3.3V

## Clock Fanout Buffers

Microchip's high-performance buffers complement clock synthesis devices by providing additional fanout capabilities and minimal jitter combined with the industry's best power supply noise rejection performance. This preserves signal integrity by adding ultra-low jitter and filtering noise from power supplies, resulting in better performance while simplifying engineering board design efforts.



Product	Input	Outputs	Output Frequency	Additive Jitter RMS	Package (mm)
ZL40xxx	1, 2, and XO, any signal type	2, 4, 6, 8 LVPECL or LVDS	750 MHz	<100 fs (as low as 39 fs)	3 × 3 and 5 × 5 QFN
ZL4024x, ZL4023x	2 inputs, XTAL, XO, any signal type	4, 5, 10 LVPECL, LVDS, HCSSL, or LVCMOS	1.6 GHz	<50 fs (as low as 25 fs)	5 × 5 QFN
ZL3024x	3 inputs, XTAL, XO, any signal type	3, 6, or 10, any native signal diff or SE, configurable by output	1 GHz	<170 fs	8 × 8 QFN

# PCIe Fanout and Storage Switches

## PFX PCIe Fanout Switches

Switchtec PFX fanout PCIe switches provide the industry's highest-density, lowest-power PCIe switch for data center, communications, workstation, and video production applications. With simple hardware configuration and advanced diagnostics and debug capabilities, the PFX enables PCIe solutions for a wide variety of systems, from Just A Bunch Of Flash (JBOF) to general-purpose applications requiring low-power and high-reliability PCIe switching.

Product	Lanes	Description	Package Type
<b>PM8531 PFX 24xG3</b>	24	PFX 24xG3, 24-lane PCIe Gen3 Fanout Switch	650-pin, 27 mm × 27 mm FCBGA package*
<b>PM8532 PFX 32xG3</b>	32	PFX 32xG3, 32-lane PCIe Gen3 Fanout Switch	650-pin, 27 mm × 27 mm FCBGA package*
<b>PM8533 PFX 48xG3</b>	48	PFX 48xG3, 48-lane PCIe Gen3 Fanout Switch	650-pin, 27 mm × 27 mm FCBGA package*
<b>PM8534 PFX64xG3</b>	64	PFX 64xG3, 64-lane PCIe Gen3 Fanout Switch	1311-pin, 37.5 mm × 37.5 mm FCBGA package*
<b>PM8535 PFX 80xG3</b>	80	PFX 80xG3, 80-lane PCIe Gen3 Fanout Switch	1311-pin, 37.5 mm × 37.5 mm FCBGA package*
<b>PM8536 PFX 96xG3</b>	96	PFX 96xG3, 96-lane PCIe Gen3 Fanout Switch	1311-pin, 37.5 mm × 37.5 mm FCBGA package*

\*1 mm ball pitch



## PFX-I Industrial Temperature Fanout Switches

Switchtec PFX-I fanout PCIe switches support the full feature set of the PFX switch with an extended industrial temperature operating\* range of  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$  ( $T_a$  to  $T_j$ ). PFX-I switches also provide the industry's highest-density and lowest-power, with simple hardware configuration and advanced diagnostics and debug capabilities. Typical applications include data center equipment, defense, industrial servers, test equipment, cellular infrastructure, access networks, metro networks and core networking.

Product	Lanes	Description	Package Type
<b>PM8571 PFX-I 24xG3</b>	24	PFX 24xG3, 24-lane PCIe Gen3 Fanout Switch	650-pin, 27 mm × 27 mm FCBGA package*
<b>PM8572 PFX-I 32xG3</b>	32	PFX 32xG3, 32-lane PCIe Gen3 Fanout Switch	650-pin, 27 mm × 27 mm FCBGA package*
<b>PM8573 PFX-I 48xG3</b>	48	PFX 48xG3, 48-lane PCIe Gen3 Fanout Switch	650-pin, 27 mm × 27 mm FCBGA package*
<b>PM8574 PFX-I 64xG3</b>	64	PFX 64xG3, 64-lane PCIe Gen3 Fanout Switch	1311-pin, 37.5 mm × 37.5 mm FCBGA package*
<b>PM8575 PFX-I 80xG3</b>	80	PFX 80xG3, 80-lane PCIe Gen3 Fanout Switch	1311-pin, 37.5 mm × 37.5 mm FCBGA package*
<b>PM8576 PFX-I 96xG3</b>	96	PFX 96xG3, 96-lane PCIe Gen3 Fanout Switch	1311-pin, 37.5 mm × 37.5 mm FCBGA package*

\*1 mm ball pitch

Note: PFX TJunction:  $0^{\circ}\text{C}$  to  $105^{\circ}\text{C}$ . PFX-I TAmbient:  $40^{\circ}\text{C}$  to TJunction:  $105^{\circ}\text{C}$ . PFX-I doesn't support Adaptive Voltage Scaling (AVS).



## PFX-L Fanout-Lite PCIe Switches

Switchtec PFX-L fanout-lite PCIe switches support up to 96 lanes, 24 ports, x4/x8/x16 port bifurcation, two Non-Transparent Bridges (NTB), hot-plug controllers, advanced diagnostics and debug, end-to-end data integrity, SRIS, and low power. The PFX-L switches maintain footprint compatibility with the PFX switch family. Typical applications for the PFX-L include data center equipment, defense, industrial servers, workstations, test equipment, video production and broadcasting equipment, cellular infrastructure, access networks, metro networks and core networking.

Product	Lanes	Description	Package Type
<b>PM8561 PFX-L 24xG3</b>	24	PFX-L 24xG3, 24-lane Fanout-Lite PCIe Gen3 Switch	650-pin, 27 mm × 27 mm FCBGA package*
<b>PM8562 PFX-L 32xG3</b>	32	PFX-L 32xG3, 32-lane Fanout-Lite PCIe Gen3 Switch	650-pin, 27 mm × 27 mm FCBGA package*
<b>PM8563 PFX-L 48xG3</b>	48	PFX-L 48xG3, 48-lane Fanout-Lite PCIe Gen3 Switch	650-pin, 27 mm × 27 mm FCBGA package*
<b>PM8564 PFX-L 64xG3</b>	64	PFX-L 64xG3, 64-lane Fanout-Lite PCIe Gen3 Switch	1311-pin, 37.5 mm × 37.5 mm FCBGA package*
<b>PM8565 PFX-L 80xG3</b>	80	PFX-L 80xG3, 80-lane Fanout-Lite PCIe Gen3 Switch	1311-pin, 37.5 mm × 37.5 mm FCBGA package*
<b>PM8566 PFX-L 96xG3</b>	96	PFX-L 96xG3, 96-lane Fanout-Lite PCIe Gen3 Switch	1311-pin, 37.5 mm × 37.5 mm FCBGA package*

\*1 mm ball pitch





## PSX PCIe Storage Switches

Switchtec PSX PCIe storage switches are engineered to scale PCIe Flash in high-performance, robust storage systems, providing the industry's highest-density, lowest-power, high-reliability switch and is also the first programmable PCIe switch with an integrated processor. Using the PSX Software Development Kit (SDK), customer can enhance PCIe switch functionality and customize error handling.

Product	Lanes	Description	Package Type
PM8541 PSX 24xG3	24	PSX 24xG3, 24-lane PCIe Gen3 Storage Switch	650-pin, 27 mm x 27 mm FCBGA package*
PM8542 PSX 32xG3	32	PSX 32xG3, 32-lane PCIe Gen3 Storage Switch	650-pin, 27 mm x 27 mm FCBGA package*
PM8543 PSX 48xG3	48	PSX 48xG3, 48-lane PCIe Gen3 Storage Switch	650-pin, 27 mm x 27 mm FCBGA package*
PM8544 PSX 64xG3	64	PSX 64xG3, 64-lane PCIe Gen3 Storage Switch	1311-pin, 37.5 mm x 37.5 mm FCBGA package*
PM8545 PSX 80xG3	80	PSX 80xG3, 80-lane PCIe Gen3 Storage Switch	1311-pin, 37.5 mm x 37.5 mm FCBGA package*
PM8546 PSX 96xG3	96	PSX 96xG3, 96-lane PCIe Gen3 Storage Switch	1311-pin, 37.5 mm x 37.5 mm FCBGA package*

\*1 mm ball pitch



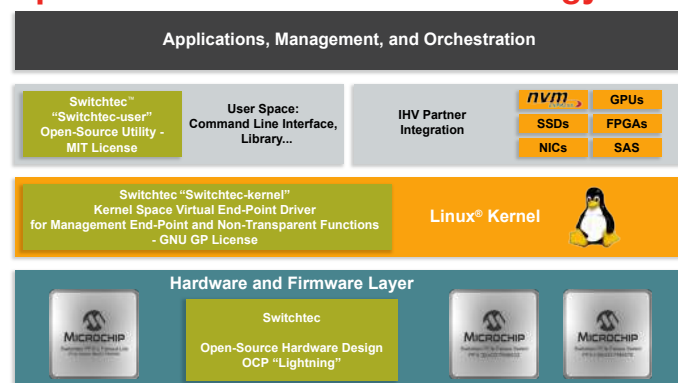
## Switchtec PAX Gen3 Advanced Fabric PCIe Switch Family

The Switchtec PAX Gen3 Advanced Fabric PCIe Switch family comprises programmable and high-reliability PCIe Gen3 switches supporting high performance PCIe fabric connectivity, multi-host sharing of SR-IOV endpoints, up to 96 lanes, 48 ports, 24 virtual switch partitions and hot- and surprise-plug controllers for each port. The switch family also features advanced error containment, comprehensive diagnostics and debug capabilities, a wide breadth of I/O interfaces, and an integrated MIPS processor. PAX switches utilize a system-on-chip architecture that optionally enables customer differentiated solutions through firmware customization and enhancements. Applications for the PAX family include scalable multi-host systems, SR-IOV enabled JBOFs, composable, disaggregated systems and rack scale architectures.

Product	Part Number	Lanes	Ports	Hot-Plug Controllers	Package
PAX 24xG3 PCIe Gen3 Advanced Fabric Switch	PM8551B-F3EIP	24	12	12	27.0 mm x 27.0 mm
PAX 32xG3 PCIe Gen3 Advanced Fabric Switch	PM8552B-F3EIP	32	16	16	27.0 mm x 27.0 mm
PAX 48xG3 PCIe Gen3 Advanced Fabric Switch	PM8553B-F3EIP	48	24	24	27.0 mm x 27.0 mm
PAX 64xG3 PCIe Gen3 Advanced Fabric Switch	PM8554B-FEIP	64	32	32	37.5 mm x 37.5 mm
PAX 80xG3 PCIe Gen3 Advanced Fabric Switch	PM8555B-FEIP	80	40	40	37.5 mm x 37.5 mm
PAX 96xG3 PCIe Gen3 Advanced Fabric Switch	PM8556B-FEIP	96	48	48	37.5 mm x 37.5 mm



## Switchtec Open Source Linux® Drivers, Hardware, Open Collaboration and Technology Sharing



# FPGA and SoC PCIe Interface Solutions

## PolarFire™ PCI Express Features

Each PolarFire FPGA integrates two low-power built-in PCIe Gen2 controllers, allowing seamless and easy connectivity to one or more host processors. The following are PCIe features:

- x1, x2, and x4 lane support
- Suitable for root port, native endpoint
- PCI Express base specification revision 2.0 and 1.1 compliant
- AXI4 master and slave interfaces to the FPGA fabric
- Single function capability
- Advanced Error Reporting (AER) support
- Integrated Clock Domain Crossing (CDC) to support user-selected AXI4 frequency
- Lane reversal support
- Legacy PCI power management support
- Native active state power management L0s and L1 state support
- Power Management Event (PME message)
- MSI and legacy INT message support
- Latency Tolerance Reporting (LTR)
- L1 PM sub-states with CLKREQ
- Address translation tables between the PCIe and AXI4 domains



## SmartFusion®2 and IGLOO®2 PCIe Features

The SmartFusion2 and IGLOO2 transceivers provide full support for PCI Express Gen 2.0. Details are provided in [SmartFusion2 Documents](https://www.microsemi.com/products/fpga-soc/soc-fpga/smartfusion2#documentation) (<https://www.microsemi.com/products/fpga-soc/soc-fpga/smartfusion2#documentation>) and [IGLOO2 Documents](https://www.microsemi.com/products/fpga-soc/fpga/igloo2-fpga#documentation) (<https://www.microsemi.com/products/fpga-soc/fpga/igloo2-fpga#documentation>) on our website.

Features include:

- Gen1/Gen2 rates at x1, x2 and x4 links
- Endpoint topology
- Single-function/single-VC
- Receiver and transmit buffers support Error Correction And Coding (ECC)
- Fabric interface options of AXI3 Master/Slave or AHB32 Master/Slave
- Address translation window support between PCIe and local device address space

## PCI-SIG Compliance

Multiple solutions from Microchip solutions have passed PCI-SIG compliance suites.

Please refer to the PCI-SIG integrators list to view [Microsemi PCI Solutions](#).

[http://pcisig.com/developers/integrators-list?field\\_il\\_comp\\_product\\_type\\_value=All&keys=microsemi](http://pcisig.com/developers/integrators-list?field_il_comp_product_type_value=All&keys=microsemi)

## Why Choose Microchip for PCIe?

Microchip keenly recognizes the importance of interoperability to address the design requirements of your PCIe network. We are actively involved in the advancement of PCIe standards, and ensures that all of our PCIe interfaced products properly conform to these standards. Microchip also regularly participates in PCI-SIG compliance workshop events, proving interoperability of our Flashtec, Switchtec, Tachyon™ and Adaptec® products. A list of our PCI Express 3.0-compliant products can be found on the PCI-SIG integrators list.

Microchip's turnkey PCIe reference designs and field-proven interoperable solutions portfolio will streamline your design, accelerating your time to market with differentiated products. Contact your local Microchip sales office today to find the right PCIe technologies and products for your design needs, or visit us at [storage.microsemi.com](http://storage.microsemi.com)

## Support

Microchip is committed to supporting its customers in developing products faster and more efficiently. We maintain a worldwide network of field applications engineers and technical support ready to provide product and system assistance. For more information, please visit [www.microchip.com](http://www.microchip.com):

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- Sales and Global Distribution: [www.microchip.com/sales](http://www.microchip.com/sales)

## Training

If additional training interests you, Microchip offers several resources including in-depth technical training and reference material, self-paced tutorials and significant online resources.

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Microchip Technology Inc. | 2355 W. Chandler Blvd. | Chandler AZ, 85224-6199